
PROPULSION DIRECTORATE

Monthly Accomplishment Report January 2005



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PR SUCCESSFULLY FIRES HYBRID ROCKET MOTOR FOR FALCON PROGRAM: A large hybrid rocket motor was successfully fired at the Propulsion Directorate's Test Stand 2A at Edwards AFB, California. The test was part of the Defense Advanced Research Projects Agency (DARPA)/Air Force [Falcon * Small Launch Vehicle Program](#). This program is a 36-month long effort to develop and demonstrate an affordable and responsive space lift launcher capable of placing a small, 1000-pound satellite into a circular orbit at 100 nautical miles altitude. The hybrid rocket differs from liquid fueled and solid propellant fueled rockets, combining technologies from both types of launchers. Typically, a hybrid rocket uses a rubberized fuel and liquid oxygen to generate thrust. This was the first hot-fire test at the [modernized Test Stand 2A](#), and it culminated a long-term effort to build-up and activate the test stand. Test Stand 2A is the nation's most modern rocket engine test stand having a capability to test propulsion systems producing thrust up to 750,000 lb_f. This successful motor firing demonstrated progress by the DARPA/Air Force team to develop an affordable, responsive, space launcher and it also demonstrated PR's capability to conduct tests of such systems. (Ms. J. Carlile, AFRL/PRSO, (661) 275-5098)

Want more information?

- ❖ An Air Force Link story is available here:
<http://www.af.mil/news/story.asp?storyID=123009762>



A large hybrid rocket motor is fired at PR's Test Stand 2A

* Falcon = Force Application and Launch from CONUS

ROCKET MOTOR SURVEILLANCE PROGRAM SAVE LIVES AND AIRCRAFT: In June 1997, an [AIM-7 Sparrow](#) rocket motor failed catastrophically during a weapon system evaluation program. This failure occurred upon missile launch and caused significant damage to the F-15 launch aircraft, nearly resulting in its loss. The production lot of motors that the mishap motor came from was restricted, though no definitive cause of the failure was determined. A subsequent, seemingly unrelated failure occurred in March 1998. In May 1998, the Propulsion Directorate learned of the failures, became involved in, and eventually led the failure investigation at the request of the Sparrow missile SPO. A definitive cause of the failures, which were actually closely related, was determined and corrective measures taken. As part of the corrective action taken, a comprehensive surveillance program was instituted. This program, defined by AFRL, included ground rules to determine when motors had to be restricted (i.e., fired only in time of war) and when they had to be condemned. Condemned motors are fired in order to gather further technical data and to de-mil them. To date, 13 motors (not including motors from the original incident production lot) have failed catastrophically when statically fired in a test stand, and 8 of those 13 were motors previously in missiles that came out of the combat theater. Clearly, the removal of these rocket motors from the inventory has had a significant positive impact on the safety of US Air Force aircrew and aircraft. (Mr. P. Huisveld, AFRL/PRS, (661) 275-5395)

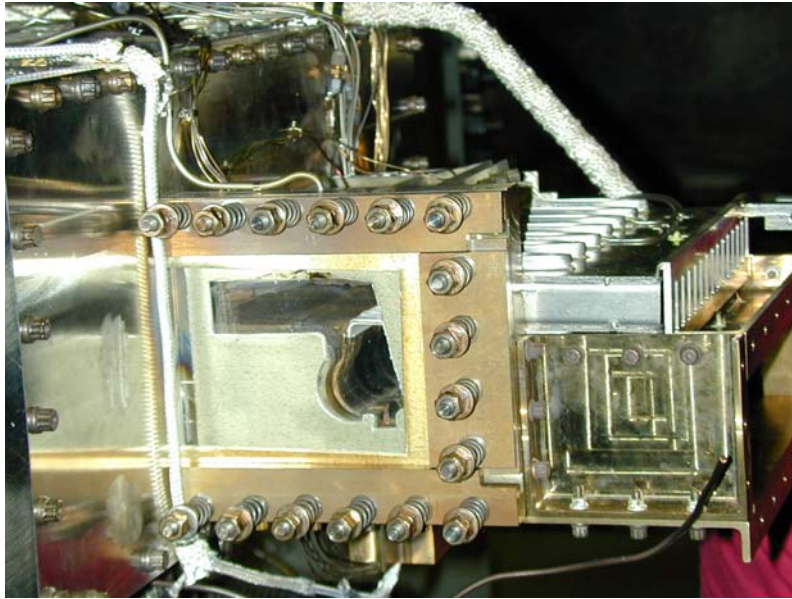


An AIM-7 Sparrow missile is launched from an F-15



Damage to an F-15 caused by a Sparrow rocket motor failure

CONFINED RECIRCULATION COMBUSTION TESTS COMPLETED: The Propulsion Directorate successfully completed high pressure combustor testing as part of a Small Business Innovation Research (SBIR) Phase I program to develop Confined Recirculation Combustion (CRC) technology for afterburning applications. The [Williams International](#) Ultra-Compact Combustor (UCC) rig, developed jointly with AFRL/PR under a previous effort, was used for



The Ultra-Compact Combustor installed in PR's High Pressure Combustion Research Facility

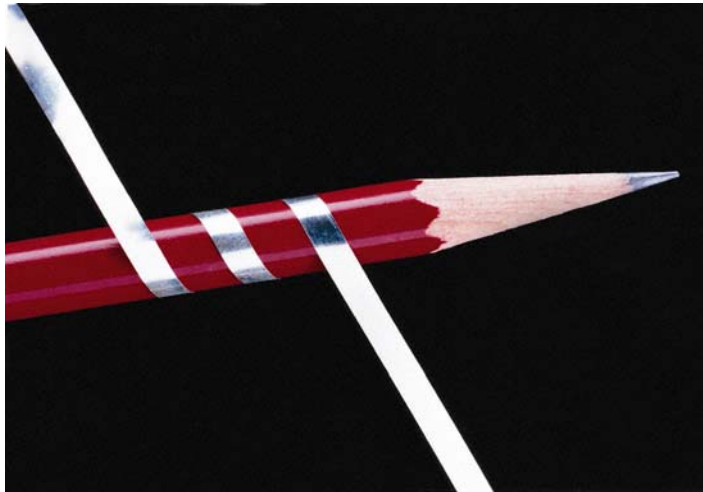
these tests conducted in AFRL/PR's High Pressure Combustion Research Facility (HPCRF). Previous tests of the UCC demonstrated excellent combustion performance over its operating range. [Spiritech Advanced Products, Inc.](#) teamed with Williams International in this SBIR to extend the confined recirculation technology base-line to higher aerodynamic loads and fuel flow rates analogous to afterburning conditions. This work involved testing the combustor over a wide range of pressures and temperatures for performance and lean

blowout. In addition, the rig was modified for subsequent tests to study the effect of mixing combusted core flow with bypass air using a scalloped strut mixer. The mixer generates vortices used to accelerate the flow throughout the exhaust section. Data from the CRC tests will be analyzed by Spiritech to determine the operability limits of the CRC, including light-off and maximum cavity fuel-to-air ratio over the range of afterburner operating pressures, temperatures, and aerodynamic loads. Further objectives are quantification of performance, including flow rate and flow split between core, bypass, and cavity as a function of pressure, and comparison with CFD models obtained for several operating conditions. This SBIR effort has been FastTrack funded as part of a follow-on Phase II award upon completion of the Phase I effort in January 2005. Combustion and afterburning technologies derived from this and future tests are being planned by the Boeing Company and Williams International for insertion into the Navy RATTILRS[†] program. (Mr. C. Frayne, Mr. D. T. Shouse, Mr. C. Neuroth, and Dr. J. Zelina, AFRL/PRTC, (937) 255-6250)

TITLE III PROGRAM STRIVES TO SCALE-UP SUPERCONDUCTOR MANUFACTURING:

The Propulsion Directorate and Materials & Manufacturing Directorate recently reviewed the progress of the two main companies preparing for manufacturing of YBCO (yttrium barium copper oxide) coated conductors, [American Superconductor](#) and [SuperPower, Inc.](#) A Defense Production Act Title III program, currently in the second phase, is in place to establish manufacturing facilities at both of these companies. Excellent progress has been achieved by both vendors in the scale-up of YBCO coated conductors. The vendors have successfully scaled-up from 10 m lengths of the YBCO conductor (up from 1 m at the start of Phase I) to currently between 30 m and 100 m lengths. Concurrent Air Force developmental efforts are focused on enhancing the basic conductor being scaled-up to include ac-tolerant versions and higher critical current improvements in the superconducting wire. The Navy, Department of Energy, and Office

[†] RATTILRS = Revolutionary Approach To Time Critical Long Range Strike



A length of YBCO coated conductor

of Secretary of Defense are contributing funding to this effort in addition to the Air Force. The availability of long lengths of this conductor will lead to compact and efficient power generation systems that have numerous defense and commercial applications. (Dr. P. Barnes, AFRL/PRPG, (937) 255-4410)

SCRAMJET ENGINE DEMO PROGRAM AWARDS FOLLOW-ON CONTRACT: The Propulsion Directorate's Scramjet Engine Demonstration (SED) Program, which

started in December 2003, successfully completed a Preliminary Design Review (PDR) in December 2004. A follow-on contract was awarded on 7 January 2005 for the detailed design of a flight demonstrator using the Hypersonic Technology (HyTech) scramjet engine design. The SED-WaveRider Consortium that will be executing the contract consists of Boeing and Pratt & Whitney. The contract, valued at approximately \$70 million, will take the program through the detailed design phase culminating with a Critical Design Review (CDR) in January 2007. A priced option was also negotiated, valued at approximately \$60 million, to enable fabrication and flight test of the SED with a first flight scheduled for December 2008. The objective of the SED Program is to flight test the USAF HyTech scramjet engine, using endothermic hydrocarbon fuel, to demonstrate acceleration of a vehicle from boost (approximately Mach 4.5) to Mach 6 to 7+. The SED Program will acquire ground and in-flight test data of an operating, actively cooled, self-controlled prototype scramjet engine. (Mr. C. Brink, AFRL/PRAT, (937) 255-7611)



Illustration of the SED-WaveRider

Want more information?

- ❖ A Pratt & Whitney Press Release on this new contract is available here:
http://www.pratt-whitney.com/pr_011304.asp

MR. HARDER HONORED FOR FINANCIAL MANAGEMENT LEADERSHIP: The Propulsion Directorate's Mr. David Harder was recently selected to receive the Exemplary Civilian Service Award. Mr. Harder was recognized for his outstanding performance from



Mr. David Harder was selected to receive the Exemplary Civilian Service Award

October 2002 to July 2004, during which time he served as the Chief of the Edwards Research Site Financial Branch (AFRL/PRFB) at Edwards AFB, California. Mr. Harder provided invaluable support to many national programs managed by PR, such as the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program and other programs related to strategic sustainment, upper stage engine technology, and space maneuver. In addition to developing key defense technologies, these programs have had major impacts on the activities of some of the largest US aerospace firms. Mr. Harder has also done an outstanding job of organizing, training, and equipping 12 acquisition professionals to meet the financial management needs of PR's Space and Missile Propulsion Division (AFRL/PRS). (Mr. P. Mitchell, AFRL/PRF, (937) 255-3044)